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Commentary

Biomedical Sciences and Mathematical Statistics in Japan: Personal Experiences and Future Outlook

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A successful application of statistics to medical sciences is our experience with analysis of data from the Cornell Medical Index-Health Questionnaire. (*1–13*). K. Fukamachi and T. Kanehisa of Kyushu University translated the Cornell Medical Index Questionnaire and tried to establish a diagnostic rule to distinguish neurotic and mentally unhealthy patients from mentally healthy patients at the department of internal medicine at Kyushu University hospital. I was approached for suggestions. After some analysis I decided to reduce the data to a bivariate form. The first component was the square root of the number of physical complaints. The reason was an intuitive one based on various scatter diagrams and also on the outcome of a preliminary statistical analysis made by Dr. Fukamachi regarding a comparison of numbers of complaints between mentally healthy patients and in healthy ones in various categories. They collected data for several years and had accumulated data on 50 solidly diagnosed psychosomatic cases and 50 nonpsychosomatic cases. I drew lines representing the linear discrimination function and added two more lines indicating what are called the "doubtful regions" in the terminology of Rao (*14*). Thus there are four regions. If the data fall in the first region, the patient is diagnosed suffering from psychosomatic illness; this is the region consisting of points deviating significantly from the mentally healthy patients' mean vector. The second region is one where patients are tentatively diagnosed suffering from psychosomatic illness; in this region the points do not lie a significant distance from those for "healthy" patients, but the value of the linear discriminant function indicates the patient has a psychosomatic complaint. The third and fourth regions are for patients provisionally diagnosed and definitively diagnosed as mentally healthy but physically ill.

The data were published (*15*) as was the application of the linear discriminant function (*16*). The questionnaires for males and females along with the discriminative charts for clinical use were also later published.

The charts drew some attention from medical doctors. Indeed, 98 papers were published within 12 years, after the charts were made available, and the area of application covers almost all of the branches of medicine, excluding pediatrics. T. Kanehisa and K. Fukamachi published a book (*17*) reviewing all these papers. The charts are still used in some clinics. The statistical methods involved in these charts are very primitive, and the calculations are simple. We used a Japanese abacus in the calculation of variance matrixes. I still remember discussions, on the logic of statistical inferences and the interpretation of outcomes of statistical analysis I had with Dr. Fukamachi, a psychiatrist and internist. It was my first encounter with real data of good quality and my first chance to explain in depth statistical logics and methods to a person without mathematical background.

This encounter left a deep impression on me as a statistician, and without this experience I would not have written later papers (*18–20*), which were motivated by discussion and consideration of the Cornell Medical Index data. These have little scientific value now, but they are cited in Giri's book (*21*). Research along this line is still continuing.

My second encounter with biomedical problems was in a research project carried out by Neel and Schull on the effect of consanguinity on Japanese children (*22*). The survey was conducted in 1958–1960, and the analysis was in 1961–1963. I was involved solely in the multivariate regression program while I was at the University of Michigan, Ann Arbor, Michigan. This was my

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Table 1. Number of U.S. and Japanese professional staffs in ABCC and RERF.[a]

Staff			Staff				
ABCC	73-74	RERF	75-78	79	80	81	82
Director's office	1 + 5	Permanent Director	3 + 2	3 + 3	2 + 2	1 + 1	2 + 2
Clinical laboratories	1 + 10	Clinical laboratories	2 + 11	2 + 11	1 + 10	1 + 11	1 + 10
Epidemiology and statistics	4 + 11	Epidemiology and statistics	9 + 13	4 + 9	3 + 9	5 + 9	7 + 11
Radiology	1 + 2	Radiology	1 + 16	1 + 2	1 + 2	1 + 2	1 + 2

[a]ABCC stands for Atomic Bomb Causality Commission; RERF denotes for Radiation Effect Research Foundation. Here, 9 + 13, say, indicates that in the annual report for 1975–78 of RERF, 9 U.S. professional staffs and 13 Japanese staffs are listed in the Department of Epidemiology and Statistics.

first exposure to modern electronic computers. The main paper (*20*) was worked out there, and the rest of my results were published in 1962 and 1963 (*23,24*).

Nearly at the same period, a Japanese team was formed to conduct studies on inbreeding in some Japanese populations. M. Kimura, a famous geneticist who proposed the neutral theory, was responsible in recruiting me as one of the statisticians in this team. The results from this study finally appeared as a series of papers in a journal whose reprints were bound in one volume and were distributed (*25*). If one compares these two reports, (*22,25*), one can imagine my astonishment and admiration of the way Americans organize research teams. I became increasingly critical of Japanese medical scientists as a whole.

The weakness of biostatistics in Japanese medical sciences is well demonstrated by the data in Table 1. The Radiation Effect Foundation (RERF) was originally the Atomic Bomb Causality Commission. Table 1 was compiled from published data (*26,27*) and indicates that in certain areas of medicine participation of Americans is not mandatory, but the presence of Americans is seriously needed in the area of biostatistics.

In 1978 I was asked to organize a U.S.–Japan Conference on Biostatistics in the Study of Human Cancer (*29*), as an activity of the U.S.–Japan Cooperative Cancer Research Program. Since that time I have become less critical of Japanese medicine, and I will make some comments on the statistics in biomedical research. Some time in the late 1960s, I met in a small meeting Dr. Carl Hammer of the Remington Rand Company. In his speech, he tried to introduce the importance of what he called "brain ware." He tried to emphasize that this is the next level after hardware and softwares. Unfortunately, nobody seems to use the word "brain ware" now, as the concept is ambiguous.

I have seen many publications in the area of medicine, which may well be called brain wares. What I mean are such publications as *Guidebook for Genetic Counseling*, or *Guidebook to Obstetricians for Correct Diagnosis of Physical Malformations* (such as anencephalia, harelip, cyclopia, etc.). These publications are routinely revised and recirculated. I would like to call it a "brain ware maintenance" activity.

If I am allowed to use a phrase to "maintain brain wares," I can formulate my comments. In the field of biostatistics, in Japan, brain wares are not well maintained. I am saying this in contrast to the areas such as diagnosis of genetic counselings, congenital malformations, etc. In these areas the manuals to the field workers are constantly renewed.

I am not suggesting that we should have Department of Biostatistics in our University system. Geneticists are doing well without their own department in our university systems. Biochemists are also doing quite well, but the research units are scattered among various schools such as science, agriculture, medicine, pharmacology, etc.

What is needed at present for biostatistics is promotion of brain ware maintenance activity, as described by a paper of Tominaga (*30*). If this conference and its proceedings make a contribution to promote such activities, I would be very happy.

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